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Abandoned Object Detection in Public Places

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Abstract: Terrorism & global security is one of the major issues worlds facing today. We have seen in recent terrorist attacks involving some suspicious bags which are left unattended at railway stations, shopping malls, airports etc. The most challenging task in video surveillance system is to detect such kind of suspicious bags. So, for that purpose it is necessary to have an efficient threat detection system which can detect & recognize strongly dangerous situations and which gives alert to the authorities in order to take appropriate action.

Our approach involves detection of abandoned baggage which is left unattended in public areas. Many methods were employed for detection of unattended objects but in this paper our focus is on the detection of abandoned objects in video surveillance system. This procedure of detection involves two stages. In first stage we are simply going to obtain foreground segments with the help of background subtraction and mean shift algorithm. In addition, with this the background subtraction is done in Hue Saturation Value color space model in order to avoid effects of illumination changes and shadows. Once foreground blobs are detected classification of foreground blobs is done in second stage based on the shape and size of binary blobs and accordingly the status of baggage is defined in order to take appropriate action. Videos are recorded at sampling rate of 25fps, at a resolution of 720x576 pixels. Few videos are used to train the algorithm. The complexity of the problem arises from obstructions present in scene, lightening conditions & shadows. Our system is able to successfully overcome these difficulties to obtain impressive results. We have used few videos for our project having different objects. Experiments were carried out in a public indoor environment.

1. Introduction

Video surveillance systems have long been in use to monitor security sensitive areas. The history of video surveillance consists of three generations of systems which are called 1GSS, 2GSS and 3GSS [1].The first generation surveillance systems (1GSS) were based on analog sub systems for image acquisition, transmission and processing. They extended human eye in spatial sense by transmitting the outputs of several cameras monitoring a set of sites to the displays in a central control room. They had the major drawbacks like requiring high bandwidth, difficult archiving and retrieval of events due to large number of video tape requirements and difficult online event detection which only depended on human operators with limited attention span. The next generation surveillance systems (2GSS) were hybrids in the sense that they used both analog and digital sub systems to resolve some drawbacks of its predecessors. They made use of the early advances in digital video processing methods that provide assistance to the human operators by filtering out spurious events. Most of the work during 2GSS is focused on real time event detection.

Third generation surveillance systems (3GSS) provide end-to-end digital systems. Image acquisition and processing at the sensor level, communication through mobile and fixed heterogeneous broadband networks and image storage at the central servers benefit from low cost digital infrastructure. Unlike previous generations, in 3GSS some part of the image processing is distributed towards the sensor level by the use of intelligent cameras.

Consumer video camera surveillance with the continuous advancements of image processing technologies is emerging for consumer world of applications. Technology for detecting objects left unattended in consumer world such as shopping malls, airports, railways stations has resulted in successful commercialization, worldwide sales and the winning of international awards. However, as a consumer video application the need is now greater than ever for a surveillance system that is robustly and effectively automated. Generally an object is said to be abandoned if it is kept at a particular space in a video surveillance system & unattended for long time. Such systems now a days using image processing algorithms for consumer world applications. The technology for detecting objects which are left unattended at places such as shopping malls, railway stations, airports results in successful commercialization. These kinds of surveillance system consist of large number of cameras and few human operators to watch the screens. But there is a limitation for a human operator to track the different objects on a screen simultaneously i.e. human can detect or keep track on up to three to four dynamic targets at the same time [1]. If a video consist of a target and an object which diverts the attention then it is difficult for a human to separate the targets and keep tracking. Another problem is with the velocity of the target, so this factor also limits the tracking ability of human [2]. Human can attend only one or two regions of the area in view at a time [3]. All these above are the limitations for the human operator, so video surveillance system is the promising solution. Automatic object detection system can detect the object & gives alert to the authority to take appropriate action so it is having better situational awareness and it quickly respond to the most dangerous situations efficiently.

Abandoned object detection is the most challenging task in video surveillance system. In this system general background subtraction algorithm is used. By using some morphological operations and mean shift algorithm foreground blobs are detected. Once the foreground blobs are detected they are classified into two categories bag and non-bag class for that purpose classifier is trained.

Consumer surveillance cameras are cheap and ubiquitous. The advent of smart consumer cameras with higher processing capabilities has now made it possible to design video surveillance systems which can contribute to the safety of people in the home and in public places such as shopping malls, airports, railways stations etc. Terrorist attacks have become a critical threat of public safety; especially, explosive attacks with unattended packages are repeatedly concentrated on such public places. A key function in such a surveillance system is the understanding of human behavior in relation with objects left unattended in public places.

3. Methodology

Our approach captures and obtains the flow of events which relates to the abandonment of an object. Figure 4.1 shows the flow graph of this method. The bag or object is said to be abandoned if and only if when owner brings the bag in video surveillance place and leaves that place without bag then that bag is said to be abandoned after some time. This algorithm is very simple and composed of two stages. In that first stage consist of two stages. In that first stage is of object detection & second stage is object classification. These stages are discussed below briefly.

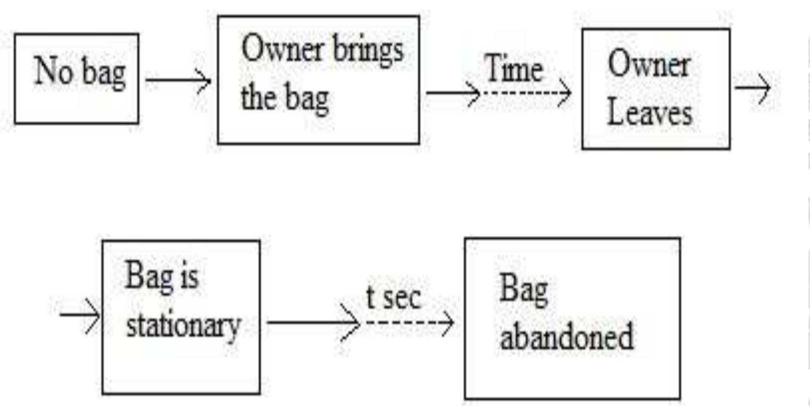

Figure 1.1. Flow Diagram of Method

A motion detection algorithm begins with the segmentation part where foreground or moving objects are segmented from the background. The simplest way to implement this is to take an image as background and take the frames obtained at the time t, denoted by I(t) to compare with the background image denoted by B. Here using simple arithmetic calculations, we can segment out the objects simply by using image subtraction technique of computer vision meaning for each pixels in I(t), take the pixel value denoted by P[I(t)] and subtract it with the corresponding pixels at the same position on the background image denoted as P[B].

In mathematical equation, it is written as:

$$P[F(t)] = P[I(t)] - P[B] \qquad \text{......} 4.1$$

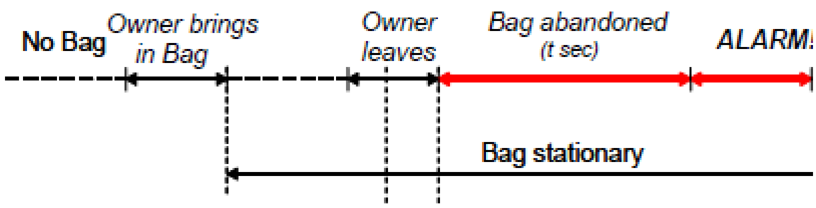

Figure 1.2: Formal Representation of Our Task

Our method is designed to capture and exploit the temporal flow of events related to the abandonment of a bag. Figure 4.2 shows the formal representation of our task. An event is defined as having occurred if and only if a given sequence of observations matches the formal event representation and meets the pre-specified temporal constraints. Here, we define the activity of the abandonment of a bag in terms of four sub-events that lead to it entry of the owner with the bag, departure of the owner without the bag, abandonment of baggage and consequent timed alarm.

Background subtraction is performed in the HSV color space, which inherently offers greater robustness to changes in illumination (such as the occurrence of shadows). A series of morphological operations is carried out to 'clean' up the image, retaining only the most useful segments. Next, the mean-shift algorithm [13] is applied for color quantization and image segmentation. Subsequent processing deals exclusively with the resultant foreground segments, or blobs.

Basic Image Processing

We perform background subtraction for the motion segmentation in static scene .This algorithm is useful to detect moving region by subtracting the current image pixel by pixel from a reference background image. Here we have considered first frame from an input video sequence as a reference frame & we have calculated the difference between each frame. The pixels where the difference is above threshold are classified as a foreground. Background subtraction is done in Hue Saturation Value color space model in order to avoid the effects of illumination changes & shadows. After detection of foreground pixel map some morphological post processing operations such as opening closing are performed in order to reduce the effect of noise and enhance the effects of noise & enhance the detected regions. For color quantization & image segmentation Mean Shift Algorithm is used because it provides better segmentation results than other approaches such as less over segmentation and avoids effects of shadows & illumination changes. Figure4.3 shows the block diagram of our method.

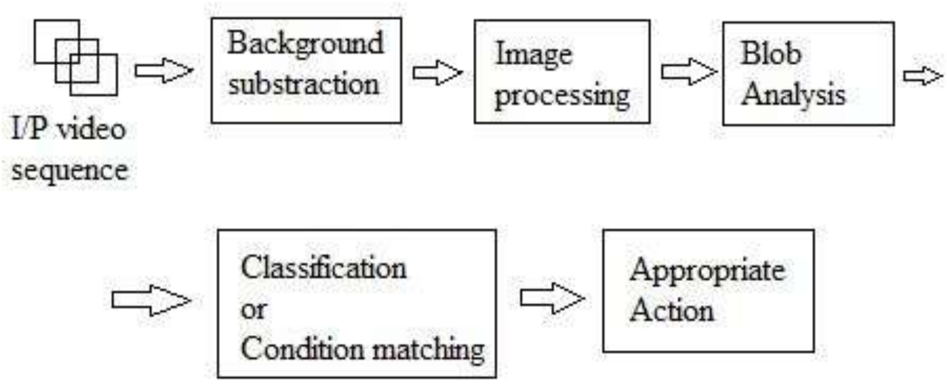

Figure 1.3. Block Diagram

Object Classification

The goal of the first module of this algorithm is to obtain foreground blobs. The second stage is of object classification. Once the foreground blobs are detected object classification is done as shown in figure 3.

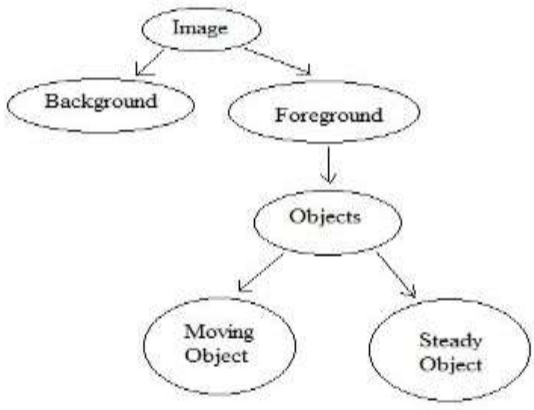

Figure 1.4. Object Classification

When any stationary baggage that seems to have been left by itself. Until such an event occurs, it is unnecessary to track and monitor all ongoing activities in the scene. Doing so not only cuts computational costs but also avoids ambiguities born of inaccuracies in tracking in the presence of much movement and occlusion.

The k-nearest neighbor classifier is used to classify foreground blobs in novel frames as belonging to the bag or non-bag class. Classification of foreground blob is based on shape and size of binary blobs. The representation of the bag is based on typical shape and size characteristics this information is obtained from the positive and negative examples provided to the system. Positive samples are manually obtained from Google image search as shown in figure 4 and then converted to binary image. Negative samples include binary blobs & irregularly shaped segments selected from the given data sequences. The classifier is trained using the following features:

1. compactness- the ratio of area to squared perimeter (multiplied by 4π for normalization)
2. solidity ratio- the extent to which the blob area covers the convex hull area
3. eccentricity- the ratio of major axis to minor axis of an ellipse that envelopes the blob
4. orientation
5. size

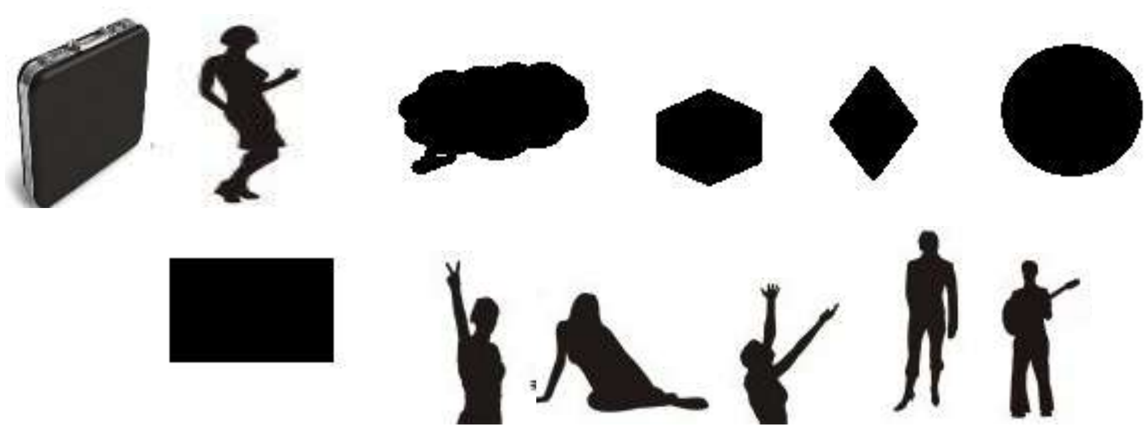

Figure 1.5.Patch Bank Consisting of Positive and Negative Samples

The size of each binary blob is coarsely normalized (using weights determined empirically) to account for the effects of perspective projection. Blobs outside a predefined range of size are excluded from consideration as possible bags. The performance of our baggage detection setup (using k = 3) is very good. Owing to the simplicity of the binary classifier and the features used, execution time is minimal. To ensure that the bag remains stationary while left alone as well as to reinforce the decision of the classifier, each suspect blob is tracked over a number of consecutive frames (usually, around 10) to check for the consistency of detection and position.

The size of each binary blob is normalized to account for the effects of perspective projection. Blobs outside a predefined range of size are excluded from consideration as possible bags.

Cross correlation with database

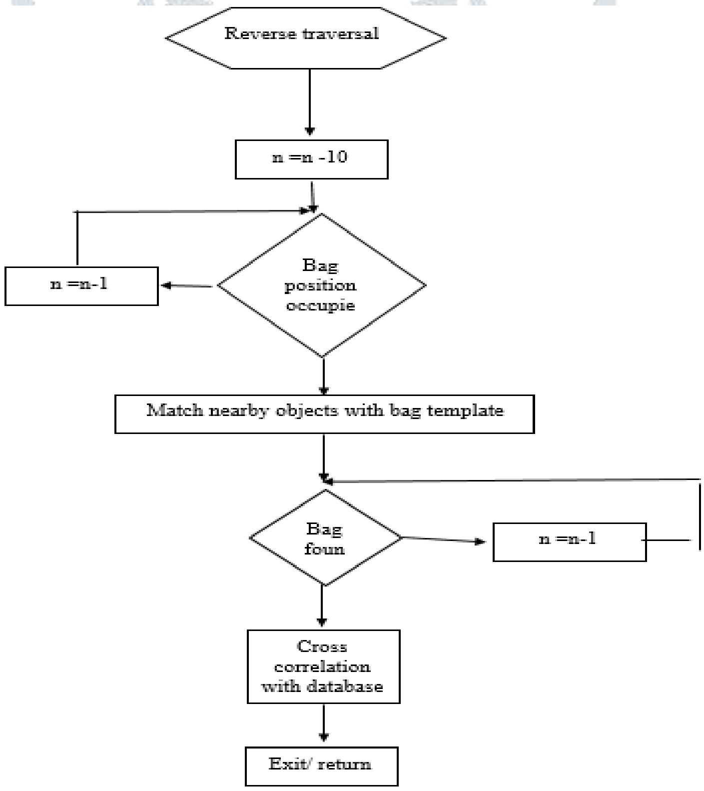

Figure 1.6: Flow Chart of Cross Correlation with Database

. 4. Experimental results

Experiments were carried out in public environment. The test video sequences used are taken by our normal video camera; our system can detect the unattended object. Figure shows the experimental results where first frame of a video sequence is stored as a background frame and next frames are compared with the background frame, figure 5.1 shows the condition of unattended object if any new object appears then it is compared with the background frame then it is detected as a unattended object.

The performances of the proposed system have been evaluated with various situations:

Sr. no.	Video number	Results obtained	
		Moving	Abandoned
1	Video 1	Human	Abandoned object
2	Video 2	Human	Abandoned object
3	Video 3	Human	Abandoned object
4	Video 4	Human	Abandoned object
5	Video 5	Human	Abandoned object
6	Video 6	Human	None

Table 1.1 Six different situation descriptions.

Videos are recorded at sampling rate of 25fps, at a resolution of 720x576 pixels. Few videos are used to train the algorithm. The complexity of the problem arises from obstructions present in scene, lightening conditions & shadows. Our system is able to successfully overcome these difficulties to obtain impressive results. We have used few videos for our project having different objects. Experiments were carried out in a public indoor environment.

5.2 Graphical User Interface:

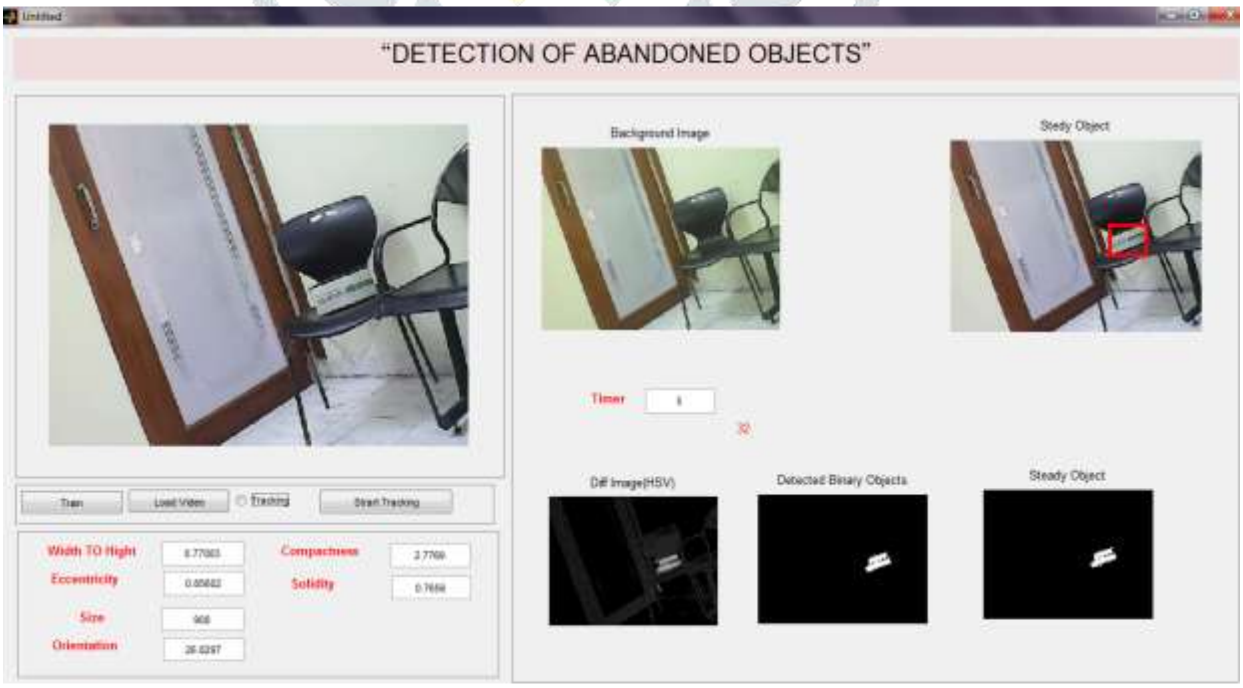

Figure 1.7: GUI - 1

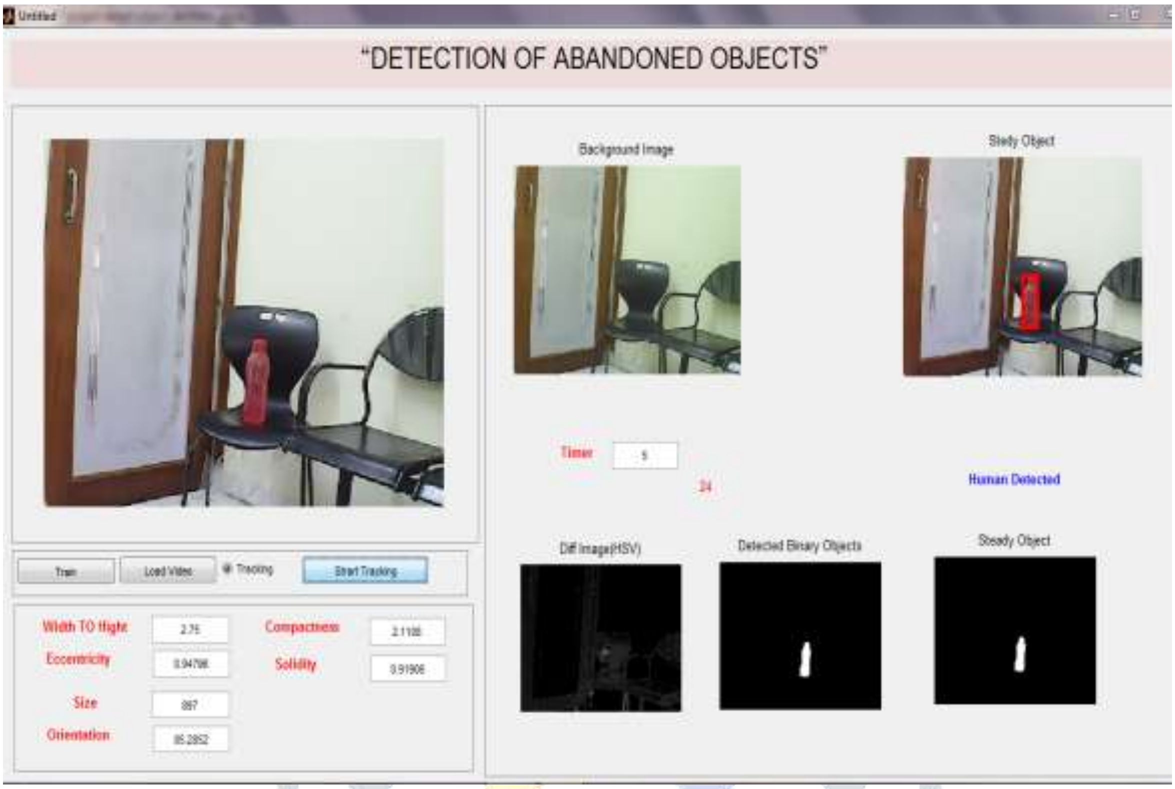

Figure 1.8: GUI - 2

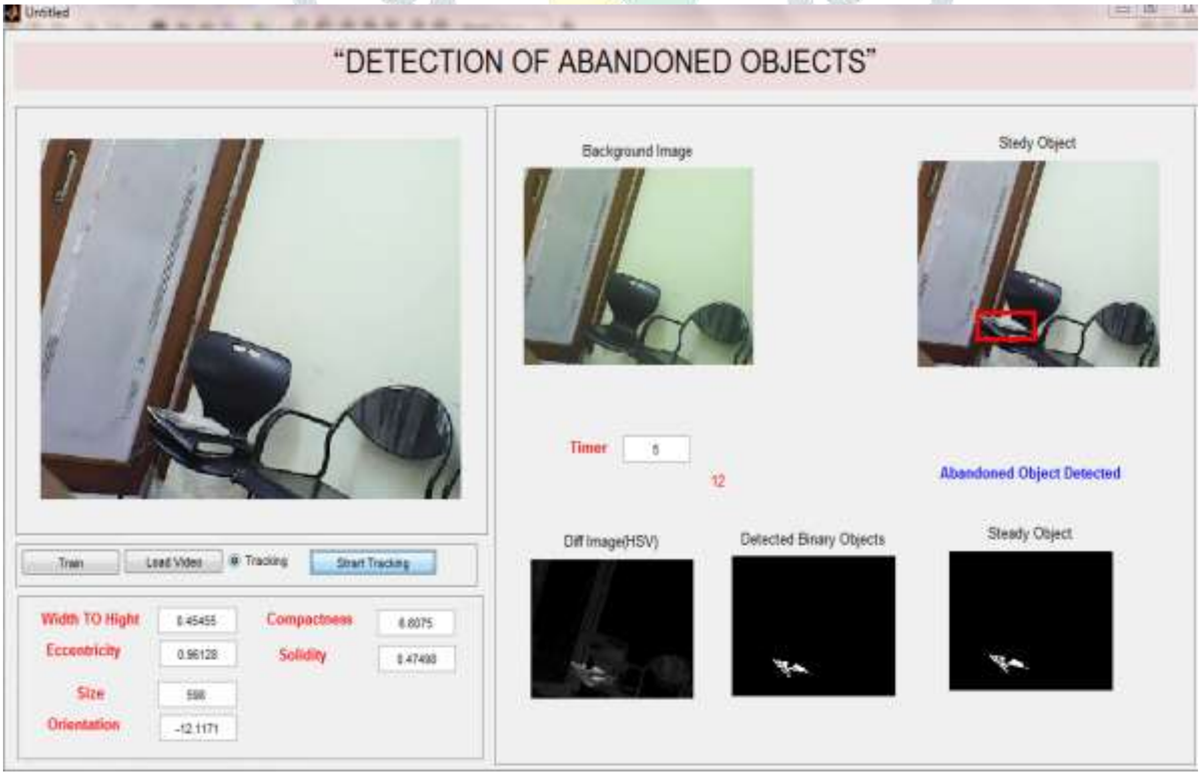

Figure 1.9: GUI - 3

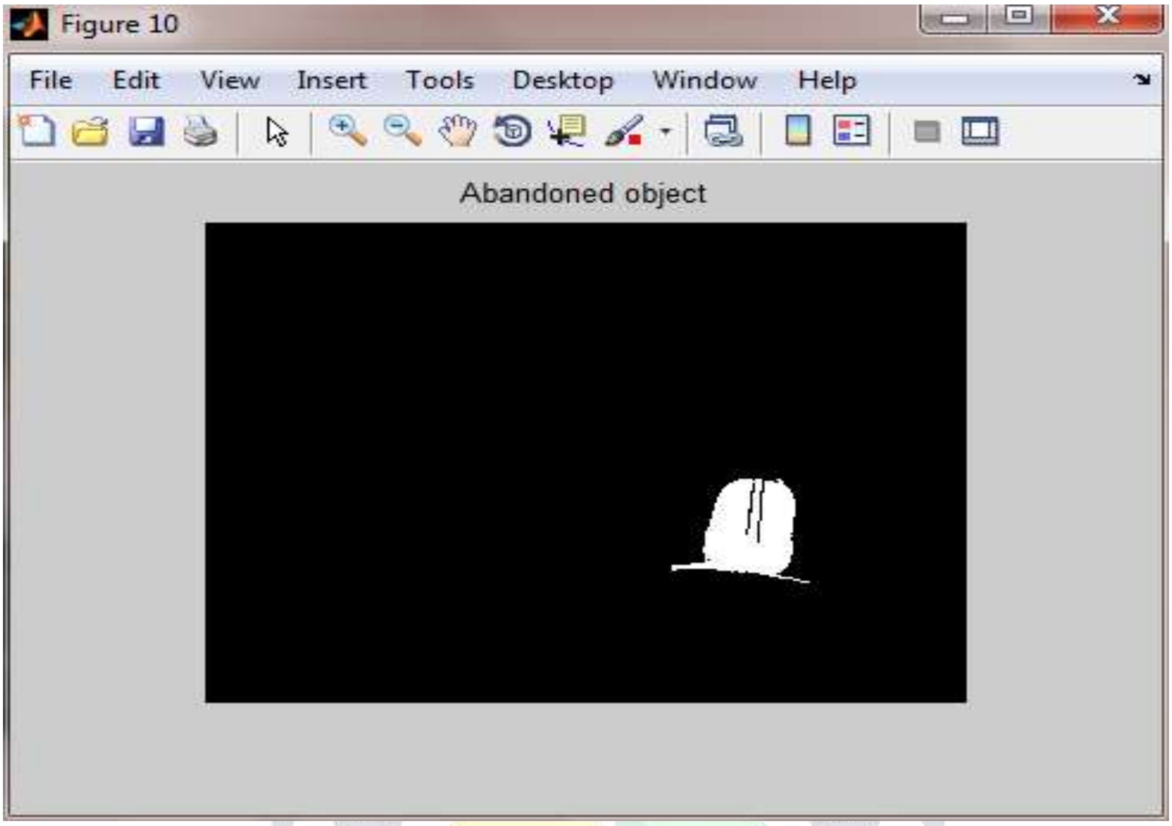

Figure 1.10: GUI - 4

5. Conclusion

This system introduces a general framework to detect the abandoned objects in public areas. The main features of this algorithm are simplicity & it is easily understood. It can detect abandoned objects easily in presence of occlusion, noise & distortion.

This system can also be applied for detecting special events such as recording a theft, robbery or monitoring school zone safety problems, for school children, thereby contributing to the safety of people in the home and schools. Due to its simplicity the computational effort is kept low and no training steps are required.

In this project a new approach for unattended object detection is presented. The considered video surveillance system aims at supporting a human operator in guarding indoor environments, such waiting rooms of railing stations or metro stations, by providing him with an alarm signal whenever a dangerous situation is detected.

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